HEATHKIT®

THE HEATH
RF SIGNAL
GENERATOR

MODEL IGW-102S

OWNER'S MANUAL

THE HEATH RF SIGNAL GENERATOR

MODEL IGW-102S

Each feature of this RF Signal Generator makes it easy to align or service communications equipment, AM or FM radios, TV sets, and other types of electronic equipment. A wide range of accurate RF output signals is provided. An audio output signal is also available.

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INTRODUCTION

The Heath Model IGW-102S RF Signal Generator is an accurate and stable source of modulated or unmodulated RF (radio frequency) signals. Six over-lapping bands provide a wide range of frequencies for use in the AM, FM, TV, LW, and SW broadcast bands.

The RF frequency is indicated on a large dial scale that is accurate and easy to read. Switch-type and continuously variable attenuators are used to obtain output signal levels that are suitable for most applications.

A built-in audio oscillator provides modulation for the RF signal and serves as a convenient source of audio signal. The RF may also be modulated by an external audio signal.

RF Direct jacks are provided to perform experiments on the time of flight of electrons as explained in the Laboratory Physics workbook, Part A, Berkeley Physics Laboratory.

OPERATION

This instrument is equipped with an Underwriters Laboratories approved 3-prong plug for your safety. An electrical outlet which has provisions for a 3-prong plug is needed to supply the AC power. If a proper outlet is not available, it is suggested that a 3-pin adapter plug be purchased from a hardware or electrical store.

Figure 1 explains the basic functions of the front panel controls. A detailed explanation of how to read the dial scale, and the use of some front panel controls, is given in the following paragraphs.

DIAL SCALE

The RF output frequency of the Generator depends on the number the dial pointer is set to, and the position of the BAND switch. Bands A, C, and E are read on the outside dial scale, bands B and D are read on the center dial scale, and band F is read on the inside dial scale. See Figure 2.

Proceed as follows to read the dial scales. On bands A and B, multiply the number indicated on the dial by 10 to obtain the frequency in kc. On bands C and D, divide the number indicated on the dial by 10 to obtain the frequency in mc.

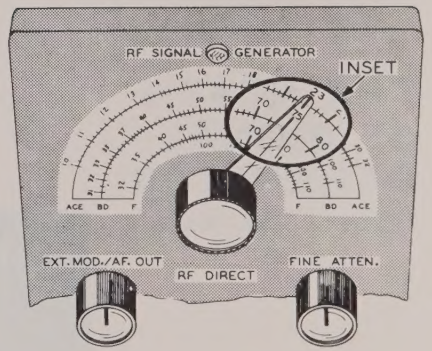


Figure 2

On bands E and F, the dial is read directly in mc. Refer to the inset drawing on Figure 2 and the following table for examples of how to read the dial scale.

BAND	DIAL READING	FREQUENCY
A	23 (multiply by 10)	230 kc
B	75 (multiply by 10)	750 kc
C	23 (divide by 10)	2.3 mc
D	75 (divide by 10)	7.5 mc
E	23 (read direct)	23 mc
F	77 (read direct)	77 mc

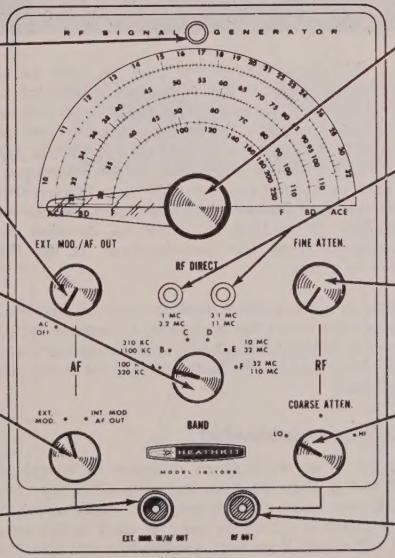
PILOT LAMP
Indicates the Generator is on by the presence of AC voltage in the power supply.

EXT MOD /AF OUT CONTROL
Turns the Generator on or off. Adjusts the level of external modulation signal or adjusts the level of internal modulation signal (400 cps) present at EXT MOD IN/AF OUT connector.

BAND SWITCH
Selects the RF frequency range on bands A through F.

MODULATION SWITCH
Selects external or internal modulation (400 cps). Also provides 400 cps AF signal at EXT MOD IN/AF OUT connector with the switch at INT MOD /AF OUT.

EXT MOD IN/AF OUT CONNECTOR
Provides 400 cps signal output or provides for input of external modulation signal.



VARIABLE FREQUENCY CONTROL
Selects and indicates the RF frequency.

RF DIRECT JACKS
Provides direct RF signal from the tuning capacitor on bands A through E.

FINE ATTEN CONTROL
Fine adjustment of RF output signal level.

COARSE ATTEN SWITCH
Coarse adjustment of RF output signal level.

RF OUT CONNECTOR
Provides RF or modulated RF output signal.

Figure 1

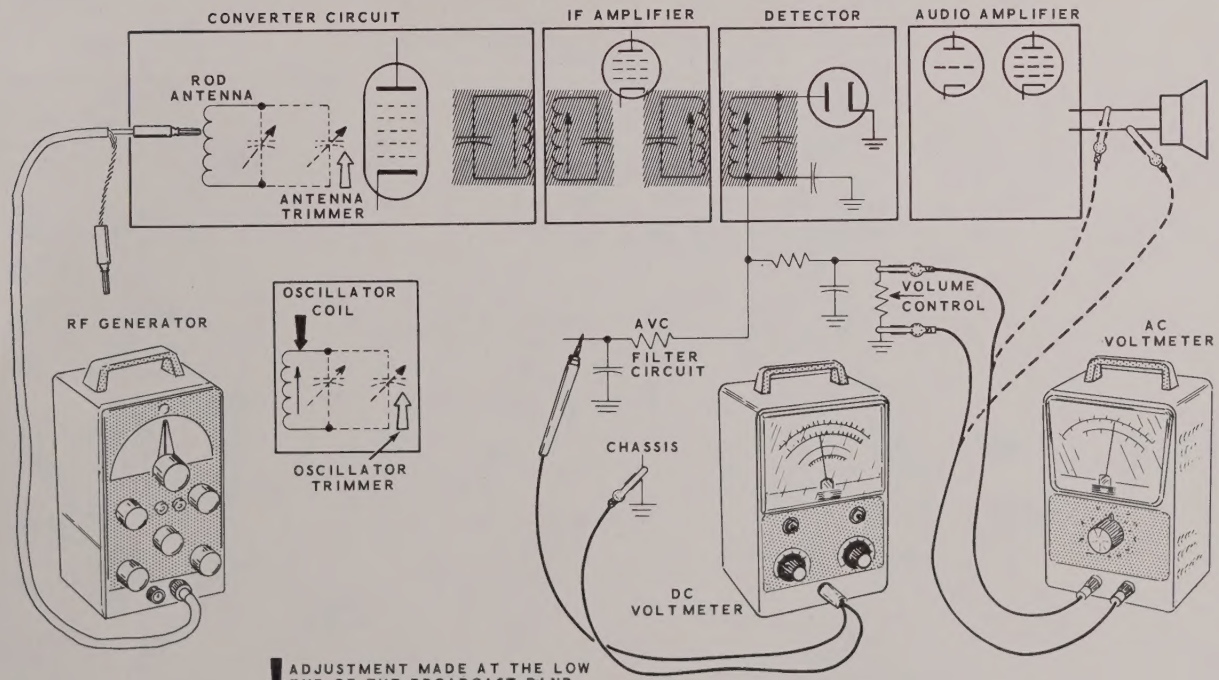

CONVERTER CIRCUIT
IF AMPLIFIER
DETECTOR
AUDIO AMPLIFIER
ROD ANTENNA
ANTENNA TRIMMER
RF GENERATOR
OSCILLATOR COIL
OSCILLATOR TRIMMER
AVC FILTER CIRCUIT
VOLUME CONTROL
AC VOLTMETER
CHASSIS
DC VOLTMETER
ADJUSTMENT MADE AT THE LOW END OF THE BROADCAST BAND.
ADJUSTMENTS MADE AT THE HIGH END OF THE BROADCAST BAND.

FIGURE 3

The numbers from 100 to 220 on the inside of scale F are calibrated harmonic frequencies of band F. This dial scale, which should be read directly, adds another range of frequencies from 100 mc to 220 mc. The most commonly used IF frequencies for AM and FM radio receivers are indicated with a special mark on the dial; 455 kc (AM) is marked on band B and 10.7 mc (FM) is marked on band E.

GENERAL

When the Modulation switch is turned to INT MOD/AF OUT, a 400 cps audio signal is available at the connector marked EXT MOD IN/AF OUT. With this switch turned to EXT MOD, the internal 400 cps oscillator is turned off, and the RF signal may be modulated by connecting an external audio signal to the EXT MOD IN/AF OUT connector. An audio signal with a level of about 3 volts is needed for 30% modulation of the RF frequency.

RF DIRECT JACKS

All test leads should be removed from the banana jacks labeled RF DIRECT when the Generator is in normal use, since the additional capacitance may prevent the Generator from operating correctly.

Special test leads are connected to the RF DIRECT JACKS when the Generator is used with the Laboratory Physics workbook, Part A, Berkeley Physics Laboratory.

APPLICATIONS

The RF Signal Generator may be used as an RF signal source for the peak alignment of tuned circuits in some FM radios and tuners. More often, though, the sweep alignment method is used to align high quality FM radios and tuners. For sweep alignment, an RF sweep generator is needed and your RF Signal Generator may be used as a marker generator. Whenever possible, it is best to follow the detailed instructions from the manufacturer of the FM radio or tuner.

There are many other applications for this Generator which are too numerous to outline in this Manual. However, two basic applications are outlined here under AM Radio Alignment and Signal Injection.

AM RADIO ALIGNMENT

Figure 3 shows a block diagram of a typical AM radio. This diagram includes all of the circuits that must be aligned. The radio speaker or a suitable voltmeter may be used as the output indicator. However, a voltmeter will indicate smaller changes in the output signal and is more desirable.

If a DC voltmeter is used, set it to measure negative DC volts and connect it to the output of the AVC filter circuit as shown. If an AC voltmeter is used, it may be connected between the two outside lugs of the volume control or across the speaker terminals.

Be sure to use the proper frequency for alignment of the IF transformers. An IF frequency of 455 kc will be used in the following procedure, since it is used in most AM radios. But your radio may use another IF frequency such as 262 kc or 460 kc.

1. Turn on the radio, RF Signal Generator, and voltmeter if one is used. Allow the equipment to warm up for 15 minutes so that all components will reach normal operating temperature.

2. Turn the AM radio dial to the high frequency end of the dial.

3. Connect the output cable to the connector labeled RF OUT on the Signal Generator.

4. If the radio uses a loop or rod antenna, place the inner or "hot" lead of the output cable near the antenna. If there is no loop or rod antenna, connect the hot lead of the output cable to the antenna terminal and the shield to the chassis of the radio.

5. Set the Signal Generator to 455 kc (Band B) and the Modulation switch to the INT MOD/AF OUT position.

6. Use an insulated alignment tool to adjust the IF transformers which are shown in the shaded portions of Figure 3. Start with the last IF transformer (next to the detector stage) and work toward the first; adjust each one for a maximum reading on the voltmeter or the loudest signal from the speaker. At the same time, reduce the Signal Generator output to keep the output of the radio at minimum but still large enough to give an indication on the voltmeter.

7. Since the IF adjustments affect each other, repeat the adjustments at least once for best results.

8. Set the Signal Generator and radio to 1600 kc. Adjust the oscillator trimmer capacitor (shown by light arrow in Figure 3) for maximum voltage reading.

9. Set the Signal Generator and radio to 1400 kc. Adjust the antenna trimmer capacitor (also shown by light arrow) for maximum voltage reading.

10. Set the Signal Generator to 600 kc and tune the AM radio to 600 kc.

11. Adjust the slug of the oscillator coil (shown by the dark arrow) for maximum reading on the voltmeter. Now tune the radio a slight amount in either direction so the signal sounds faint or the voltage reading decreases slightly. Again adjust the oscillator coil for maximum voltage, then note whether the voltage is larger or smaller than it was before. Retune the radio a slight amount again, in the same direction if the voltage increased, and in the other direction if the voltage decreased, and adjust the oscillator coil for maximum voltage. Repeat this retuning and coil adjustment process until you locate the oscillator coil adjustment that produces the largest reading on the voltmeter.

12. Repeat steps 8 through 11 again because there will be some interaction between the adjustments.

This completes the alignment of the AM radio.

SIGNAL INJECTION

Signal injection is a technique used to troubleshoot weak or dead electronic devices (radio and TV receivers, hi-fi amplifiers, etc.), to find the circuit that is not operating properly. In this method, a signal is coupled into the stages of the defective equipment, one stage at a time, until the defective stage is located.

A coupling capacitor (.05 μfd) should always be used with the hot lead to keep DC voltages from being connected to the Signal Generator. Also, care should be used so the test signal does not overdrive the stage it is connected to.

For example, this method might be used to find an open coupling capacitor between two amplifier stages. In this case, the signal would be heard when the 400 cps audio signal from the Signal Generator is connected to the control grid of the second tube. This is shown as point G in Figure 4. The signal will not be heard when the Signal Generator is connected to the plate of the first tube (point P).

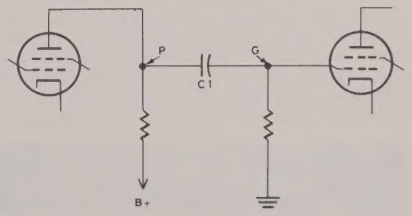


Figure 4

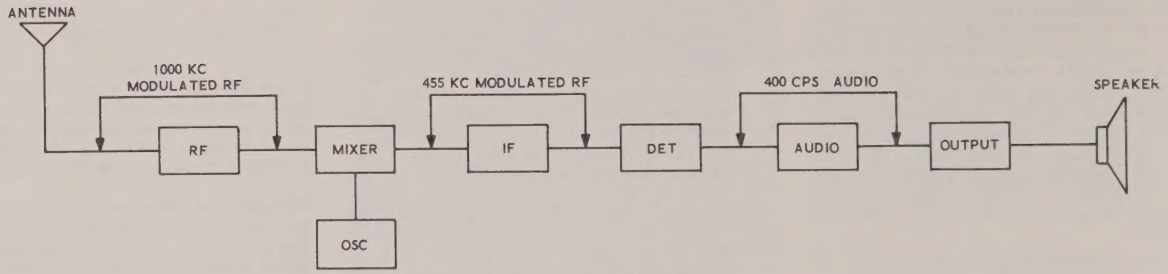


Figure 5

Figure 5 shows how signal injection can be used to find the faulty stage of an AM radio receiver. First the 400 cps audio signal from the Signal Generator is connected to the grid of the output tube, then the hot lead of the Signal Generator is moved back to the audio amplifier tube. If a normal sound is heard from the speaker in both cases, a modulated RF signal would be used to check the remaining stages of the radio. The modulated RF frequencies shown in Figure 5 would be used.

CALIBRATION

All bands have been completely calibrated at the factory. In the future, if it should become necessary to replace the RF oscillator tube V1 or other components in the RF oscillator circuit, the Generator should be recalibrated using the following procedure.

BANDS A THROUGH E

An AM radio and an alignment tool or screwdriver with a small blade are needed to calibrate bands A, B, C, D, and E.

( ) Turn the BAND switch to band B.

( ) Turn the Modulation switch to EXT MOD.

( ) Turn the FINE ATTEN control fully clockwise.

( ) Set the COARSE ATTEN switch at HI.

( ) Connect the shielded output cable to the Generator RF OUT connector. Place the free end of this cable near the loop or antenna lead of the AM radio, but do not connect it directly to the radio.

( ) Turn on the Generator and AM radio. Allow the Generator and radio to warm up for 15 minutes so all components will reach normal operating temperature.

The following procedure is used to calibrate the Generator.

First, a signal of known frequency is tuned in on the AM radio. Then the dial pointer of the Generator is set to the exact frequency of the station the radio is tuned to. The RF oscillator is then tuned to the same frequency as the radio station by adjusting it until a "zero beat" is heard in the radio.

This zero beat is the signal that is created by the beating together of the oscillator signal and the station signal in the radio. When the beat is heard, it starts out as a high pitched tone, which

gradually changes as the beat frequency becomes lower until the tone becomes very low pitched. Once the zero beat point is passed, the tone gradually increases in pitch until it can no longer be heard.

At these frequencies it is often hard to get a complete zero beat between the signals (no sound at all). Often, a low pitched tone or a slow popping sound will be as close as you will be able to come to a complete zero beat. The output level of the Generator should be just high enough to give a clear beat sound; do not set the Generator output level higher than necessary.

( ) Tune the AM radio to a station of known frequency between 700 kc and 800 kc. The frequency of this station should preferably be one whose frequency falls directly on one of the calibration points on the dial, such as 700 kc, 750 kc, or 800 kc.

( ) Turn the dial pointer on the Generator to the place on the dial that indicates the exact frequency of the station the radio is tuned to.

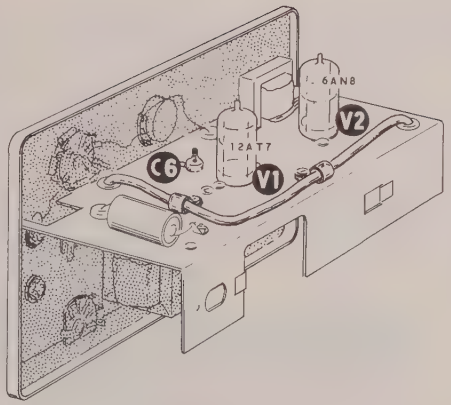


Figure 6

( ) Refer to Figure 6 and adjust trimmer capacitor C6 for a zero beat in the radio. Use the FINE ATTEN and COARSE ATTEN controls to set the output level of the Generator just high enough to give a clear zero beat in the radio.

This completes the calibration of bands A through E. Turn off the AM radio.

A slight improvement in accuracy could be obtained if the slug in each coil was adjusted by zero beating the Generator signal with an accurate frequency standard. An accurate frequency standard could be obtained by tuning a communications receiver to a WWV frequency such as 2.5 mc, 5 mc, 10 mc, etc., (National Bureau of Standards). Standard frequencies can also be obtained from a precision laboratory generator (with an accuracy of at least 1%), in conjunction with an oscilloscope to indicate the zero beat. If the coil slugs are adjusted, each band should be adjusted near the low end of the dial using an insulated coil alignment tool. Refer to Figure 7 for the location of the coil for each band.

BAND F

An FM radio is needed to calibrate band F.

( ) Turn on the FM radio and tune it to a station between 88 mc and 100 mc.

( ) Set the BAND switch to band F, and turn the dial pointer to the frequency of the FM station.

( ) Turn the Modulation switch to INT MOD/AF OUT.

( ) Connect the output cable of the Generator to the antenna terminals of the FM radio.

( ) Turn the Generator dial pointer back and forth and listen for the 400 cps tone modulation in the FM radio. This 400 cps tone will be weakest at the correct frequency, and it will be louder on both sides of this frequency.

( ) Turn the Generator dial pointer to the place where the 400 cps tone is weakest. If the dial indicator points to a frequency lower than the station frequency, gently squeeze together the turns of coil F. Coil F is located at the rear of the tuning capacitor as shown in Figure 7.

( ) Retune the dial pointer to the weakest 400 cps tone. Repeat the above procedure until the correct frequency is indicated on the Generator dial. If the dial pointer indicates a higher frequency than the station frequency, the turns of coil F should be spread apart slightly.

This completes the calibration of the RF Signal Generator.

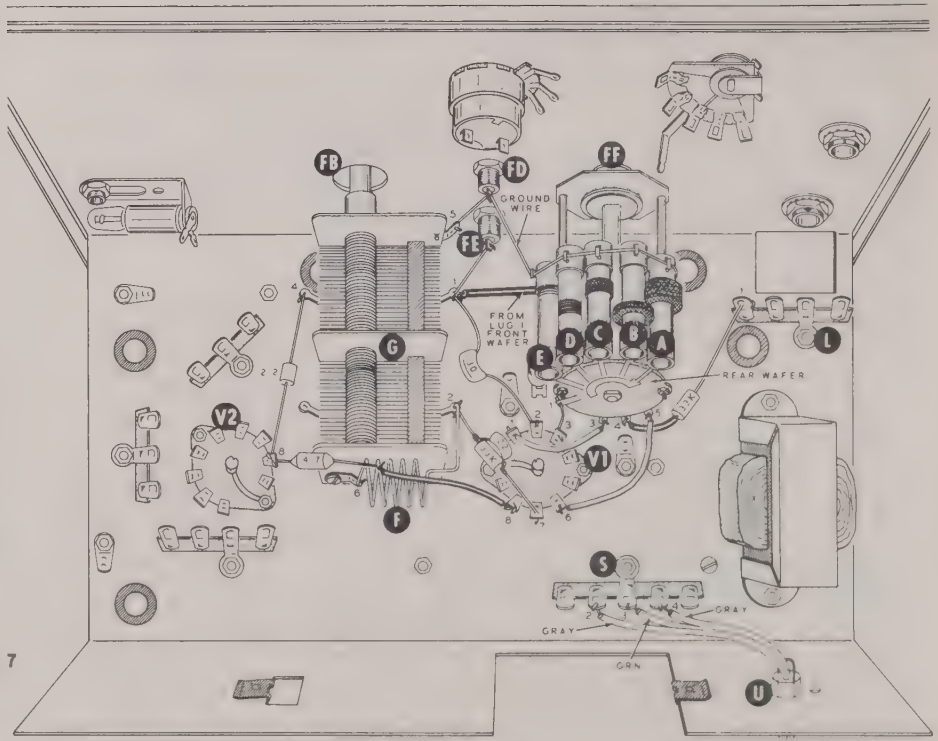


Figure 7

IN CASE OF DIFFICULTY

1. Refer to the Troubleshooting Chart to help locate the difficulty. Figure 6 shows the location of the tubes.

2. Check the tubes with a tube tester or by substitution of tubes of the same types and known to be good.

3. If, after careful checks, the trouble is still not located and a suitable meter is avilable, check voltage readings against those shown on the Schematic (fold-out from Page 11). NOTE: All voltage readings were taken with an 11 megohm input vacuum tube voltmeter. Voltages and resistances may vary as much as 10%.

4. A review of the Circuit Description will prove helpful in indicating where to look for trouble.

TROUBLESHOOTING CHART

DIFFICULTY	POSSIBLE CAUSE
Pilot lamp and tubes do not light.	1. Open on-off switch. 2. Faulty power transformer.
No RF output signal.	1. Check tubes V1 and V2. 2. Remove test leads from RF Direct Jacks. 3. Shorted or open output cable.
No modulation present on RF output signal.	1. Check tube V2.
No B+ voltage.	1. Check diode D1. 2. Check resistor R17, capacitor C25A, and capacitor C25B.

REPLACEMENT PARTS

This list covers only those items that may be difficult to obtain locally if replacement is required.

PART No.	DESCRIPTION
COIL-CAPACITORS	
40-193	Band F oscillator coil
31-8	1-10 $\mu\mu$f trimmer capacitor
26-57	Dual tuning capacitor
CONTROLS-TRANSFORMERS-SWITCHES	
10-27	3000 Ω control
19-11	100 KΩ control with SPST switch
51-44	Oscillator transformer
54-92	Power transformer
63-70	3-position rotary switch
63-211	2-position rotary switch
163-2	Band switch and coil assembly
MISCELLANEOUS	
100-M10	Dial pointer assembly
462-187	Pointer knob
462-140	Large knob
211-15	Handle
90-253	Cabinet
203-413F764-766-P187	Front panel

SPECIFICATIONS

RF OUTPUT SIGNAL

Frequency Range -
100 kc to 110 mc in six bands (bands A through F).
100 mc to 220 mc (additional band of calibrated harmonics).

Frequency Accuracy -
±3% (when RF Direct Jacks are not used).

Output Voltage -
.1 volt or higher.

Output Impedance -
50 ohms.

Internal Modulation -
400 cps (30% modulation).

External Modulation -
3 volt signal input for 30% modulation.

AF OUTPUT SIGNAL

Frequency -
400 cps.

Output Voltage-
10 volts (open circuit).

GENERAL

Front Panel Controls -
Variable Frequency control.
Band switch.
Fine Attenuator control.
Coarse Attenuator switch.
External Modulation or AF Output control.
Modulation switch.

Tube Complement -
12AT7 RF oscillator.
6AN8 amplifier and modulator.

Power Requirements -
105 to 125 volts AC, 50/60 cps, 15 watts.

Cabinet Dimensions -
6-1/2" wide x 9-1/2" high x 5" deep.

Net Weight -
4-1/2 lbs.

CIRCUIT DESCRIPTION

Refer to the Block Diagram and Schematic to follow the circuit and identify the circuit components while reading this description.

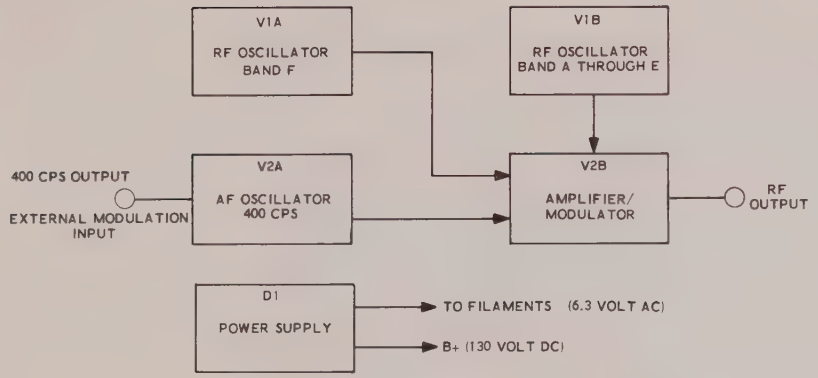
The Circuit Description of the RF Signal Generator is outlined in four sections: RF Oscillator, AF Oscillator, Amplifier And Modulator, and Power Supply.

RF OSCILLATOR

A Hartley oscillator, consisting of tube V1B and its associated circuitry, is used to generate the RF signal for bands A, B, C, D, and E. The correct coil for each band of frequencies is selected by Band switch S2.

Section BF of Band switch S2, supplies B+ voltage to the plate of tube V1B when the switch is in positions A through E. The desired oscillator coil is connected through capacitor C7 to the grid of tube V1B by section AF of Band switch S2. The tap of each coil is connected to the cathode of tube V1B by section BR of Band switch S2. Section AR of Band switch S2 shorts out all oscillator coils except the one being used.

Capacitor C9, which is one section of the tuning capacitor, is connected across the desired oscillator coil and completes the tuned circuit of the RF oscillator. Trimmer capacitor C6, which is connected to the grid of tube V1B, adjusts the oscillator frequency on bands A through E. Resistor R3 and capacitor C7 supply bias voltage to the grid of tube V1B. The RF signal is coupled through capacitor C8 to the grid of tube V2B.



BLOCK DIAGRAM

Two jacks, labeled RF Direct, are connected across capacitor C9 to serve as a direct source of RF signal.

Tube V1A is the RF oscillator stage for band F only. Coil F is permanently connected to the grid of tube V1A through resistor R1 and capacitor C3. This helps reduce variations in wiring capacitance that would occur if this coil were switched like the other coils. These variations will cause the dial calibration to be inaccurate on band F.

Capacitor C1, which is one section of the tuning capacitor, is connected across coil F to complete the tuned circuit for band F. Section BF of Band switch S2 supplies B+ voltage to the plate of tube V1A when the switch is in position F. Capacitor C3 and resistor R1 supply bias voltage to the grid of tube V1A. The RF signal is coupled from the cathode of tube V1A through capacitor C4 to the grid of tube V2B.

AF OSCILLATOR

Tube V2A, which is connected as an AF oscillator, is tuned by transformer T2 and capacitor C15 to oscillate at a frequency of about 400 cps. The 400 cps audio signal is coupled from the plate of tube V2A through capacitor C17 and resistors R7 and R8 to the grid of tube V2B. This audio signal is also applied across control R4 and through capacitor C11 to the AF Output Connector.

When switch S3 is in the External Modulation position, tube V2A is used to amplify the external modulation signal that is connected to the External Modulation In connector. This signal is coupled through capacitor C11 to control R4, and then to the grid of tube V2A. The signal is then amplified by tube V2A and coupled through capacitor C17 and resistors R7 and R8 to the grid of tube V2B.

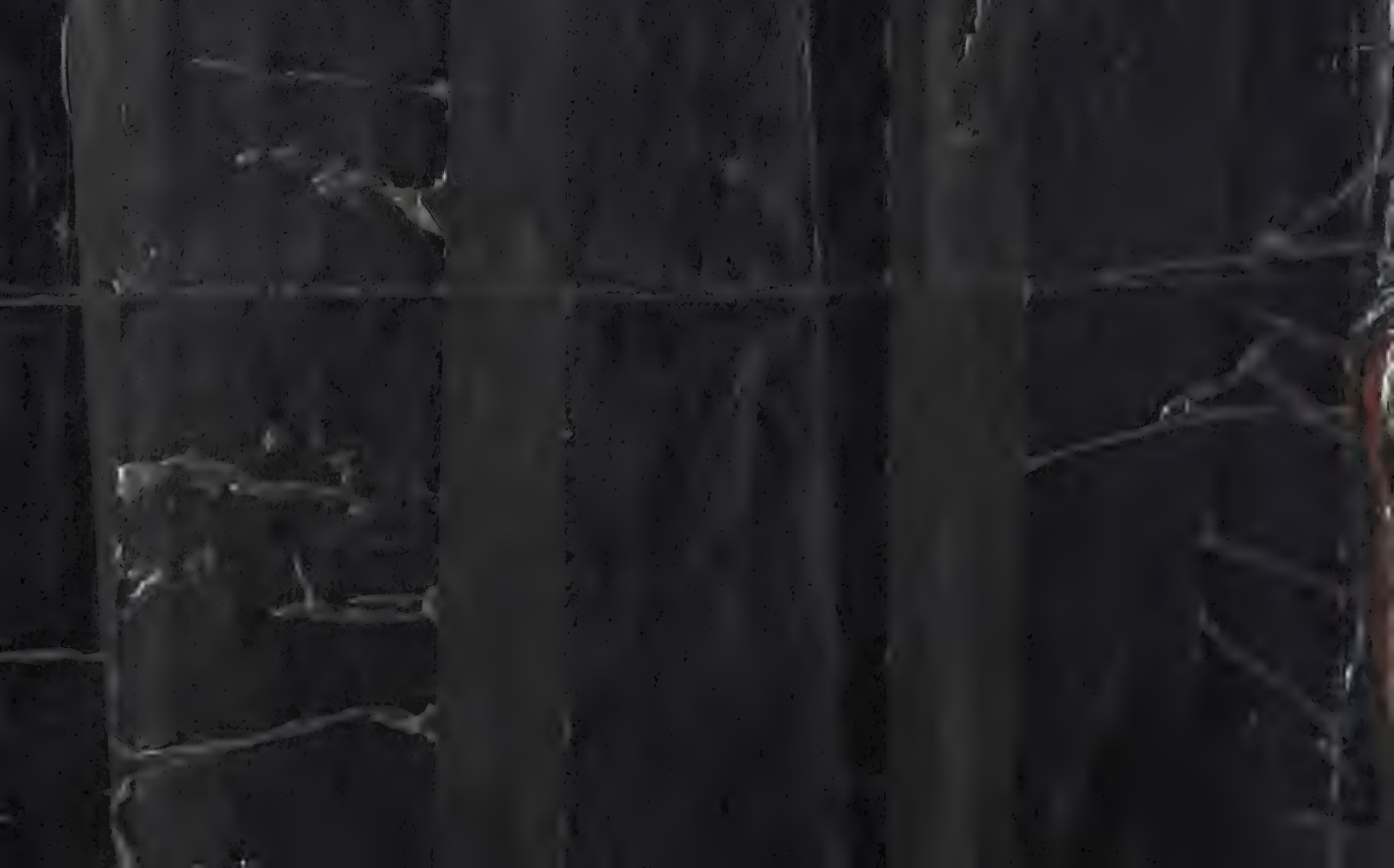
AMPLIFIER AND MODULATOR

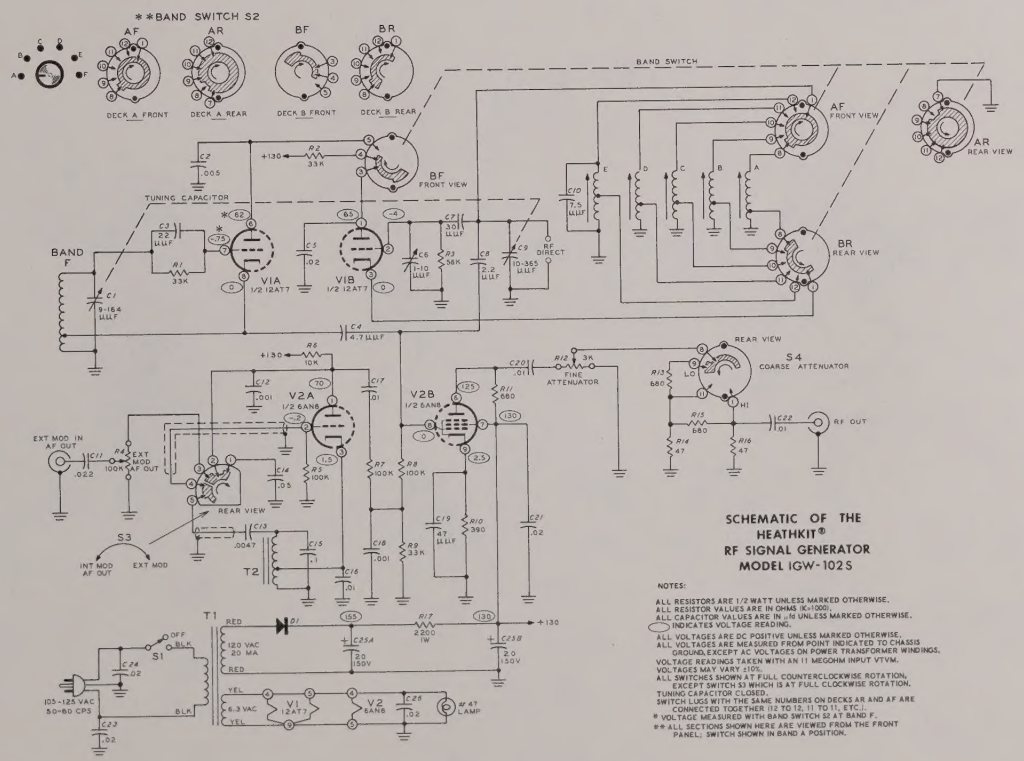
The RF and AF signals are coupled to the grid of tube V2B. Resistors R7 and R9 keep the AF signal from overdriving the grid of tube V2B and also determine the modulation level. From the plate of tube V2B, the modulated RF signal is coupled through capacitor C20, Fine Attenuator control R12, Coarse Attenuator switch S4, and capacitor C22 to the RF Output connector.

POWER SUPPLY

B+ voltage is supplied to all stages of the Generator by a half-wave rectifier circuit consisting of diode D1. Resistor R17 with capacitors C25A and C25B provide filtering of the B+ voltage.

Filament voltage is supplied to the filaments of all tubes and the #47 lamp by a 6.3 volt AC winding on power transformer T1.





SCHEMATIC OF THE HEATHKIT® RF SIGNAL GENERATOR MODEL IGW-102S

NOTES:

ALL RESISTORS ARE 1/2 WATT UNLESS MARKED OTHERWISE.
ALL RESISTOR VALUES ARE IN OHMS (K=1000).
ALL CAPACITOR VALUES ARE IN μfd UNLESS MARKED OTHERWISE.
( ) INDICATES VOLTAGE READING.
ALL VOLTAGES ARE DC POSITIVE UNLESS MARKED OTHERWISE.
ALL VOLTAGES ARE MEASURED FROM POINT INDICATED TO CHASSIS GROUND, EXCEPT AC VOLTAGES ON POWER TRANSFORMER WINDINGS.
VOLTAGE READINGS TAKEN WITH AN 11 MEGOHM INPUT VTVM. VOLTAGES MAY VARY ±10%.
ALL SWITCHES SHOWN AT FULL COUNTERCLOCKWISE ROTATION, EXCEPT SWITCH S3 WHICH IS AT FULL CLOCKWISE ROTATION.
TUNING CAPACITOR CLOSED.
SWITCH LUGS WITH THE SAME NUMBERS ON DECKS AR AND AF ARE CONNECTED TOGETHER (12 TO 12, 11 TO 11, ETC.).
* VOLTAGE MEASURED WITH BAND SWITCH S2 AT BAND F.
** ALL SECTIONS SHOWN HERE ARE VIEWED FROM THE FRONT PANEL; SWITCH SHOWN IN BAND A POSITION.

WARRANTY

Heath Company warrants that all Heathkit parts shall be free of all defects in materials and workmanship under normal use and service, and in fulfillment of such warranty Heath Company will, for a period of three months from the date of shipment, replace any part upon verification that it is defective.

The foregoing warranty shall apply only to the original buyer, and is and shall be in lieu of all other warranties, whether express or implied and of all other obligations or liabilities on the part of Heath Company and in no event shall Heath Company be liable for any anticipated profits, consequential damages, loss of time or other losses incurred by the buyer in connection with the purchase, assembly or operation of Heathkits or components thereof. No replacement shall be made of parts damaged by the buyer in the course of handling or assembling Heathkit equipment.

The foregoing warranty is completely void if corrosive solder or fluxes have been used in wiring the equipment. Heath Company will not replace or repair any equipment in which corrosive solder or fluxes have been used.

This warranty applies only to Heath equipment sold and shipped within the continental United States including APO and FPO shipments. Warranty replacement for Heathkit equipment outside the United States is on an f.o.b. factory basis. Contact the Heathkit authorized distributor in your country or write: Heath Company, International Division, Benton Harbor, Michigan, U.S.A.

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